If an existing sag vertical curve does not meet the comfort criteria presented in Figure 55-4A or there is a history of accidents related to the curve (i.e., reconstruction may be warranted), a benefit/cost study should be conducted to determine if the proposed correction will be cost effective. Chapter Fifty presents the Department's procedures for conducting a benefit/cost analysis. If improvement in accordance with Section 44-3.0 is shown to be cost-effective and it is decided not to undertake the work, it will be necessary to request a Level One design exception.

55-4.04(05) Curves in Series

Frequently, the vertical alignment of a segment of a roadway consists of a series of sag and crest vertical curves or vertical curves connected by short grades. A succession of vertical curves may be analyzed as a unit rather than as individual curves, applying the criteria in Sections 55-4.04(03) and 55-4.04(04). Analysis procedures similar to Section 55-4.03(05) Items 1 through 4 should be followed:

55-4.04(06) Angle Points

It is acceptable to retain an existing "angle" point (i.e., no vertical curve) of 0.5% for crest vertical curves and 1.0% for sag vertical curves on a 3R project.

55-4.05 Cross Section Elements

Chapters Forty-five and Fifty-three present the Department's criteria for cross section elements for new construction/reconstruction projects. The tables in Section 55-3.0 present the cross section criteria for 3R projects. In general, the criteria were established as follows:

1. Upper Limit. The upper limit (or "desirable") of the range has been established as equal to the upper level for new construction criteria. On 3R projects, these still provide a desirable objective for the design of the cross section elements.

Design Speed (km/h)	Calculated K Values ($K = V^2/395$)	K Values Rounded For Design
30	2.3	3
40	4.1	5
50	6.3	7
60	9.1	10
70	12.4	13
80	16.2	17
90	20.5	21
100	25.3	26
110	30.6	31
120	36.5	37

$$L = \frac{AV^2}{395} = KA$$

Where:
L   =   *Length of vertical curve, m*
A   =   *Algebraic difference between grades, %*
K   =   *Horizontal distance required to effect*
           a 1% change in gradient
V   =   *Design speed, km/h*

K-VALUES FOR SAG VERTICAL CURVES
(Comfort Criteria — 3R Projects)

Figure 55-4A

Design Speed (km/h)	Calculated K Value	Minimum K Value Rounded for Design
50	1.0	1
60	2.2	3
70	6.2	7
80	8.9	9
90	15.8	16
100	24.8	25
110	35.6	36
120	48.5	49

K VALUES FOR CREST VERTICAL CURVES
(Comfort Criteria, 3R Projects)

Figure 55-4B